Design of the MISMIP+, ISOMIP+, and MISOMIP ice-sheet, ocean, and coupled ice sheet-ocean intercomparison projects

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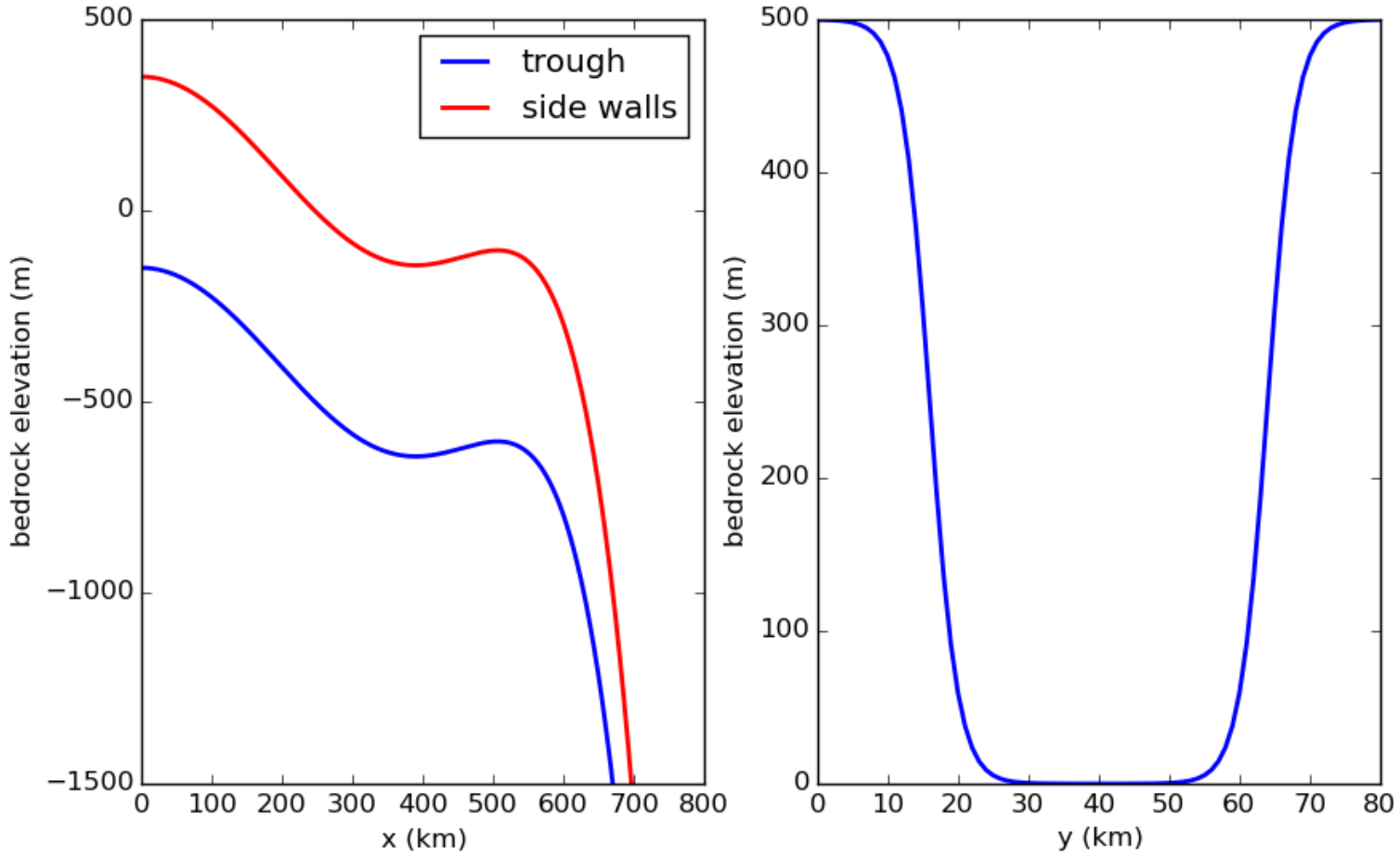
“Rising Coastal Seas on a Warming Earth”

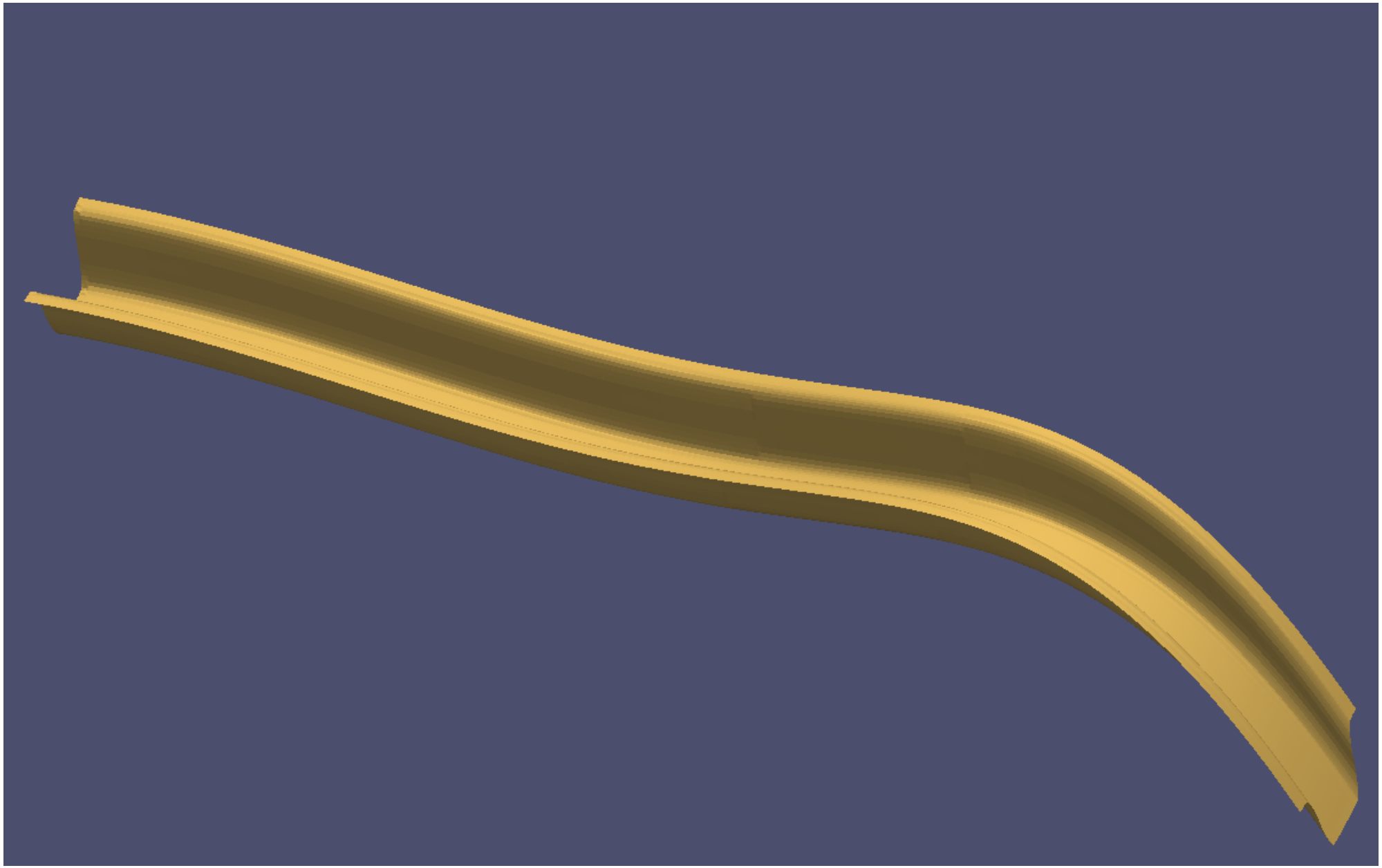
- November 2014
- Organized by David and Denise Holland
- Supported by the WCRP Climate and Cryosphere (CliC) and NYU Abu Dhabi
- Intercomparisons from idealized to realistic
- Community effort toward understanding climate change in West Antarctica
- 5 year time horizon
- Coordinate with MISMIP and ISMIP6

MISMIP+

- Third Marine Ice Sheet Model Intercomparison Project
- Bedrock topog. based on Gudmundsson et al. (2012)



MISMIP+ bedrock (bathymetry)



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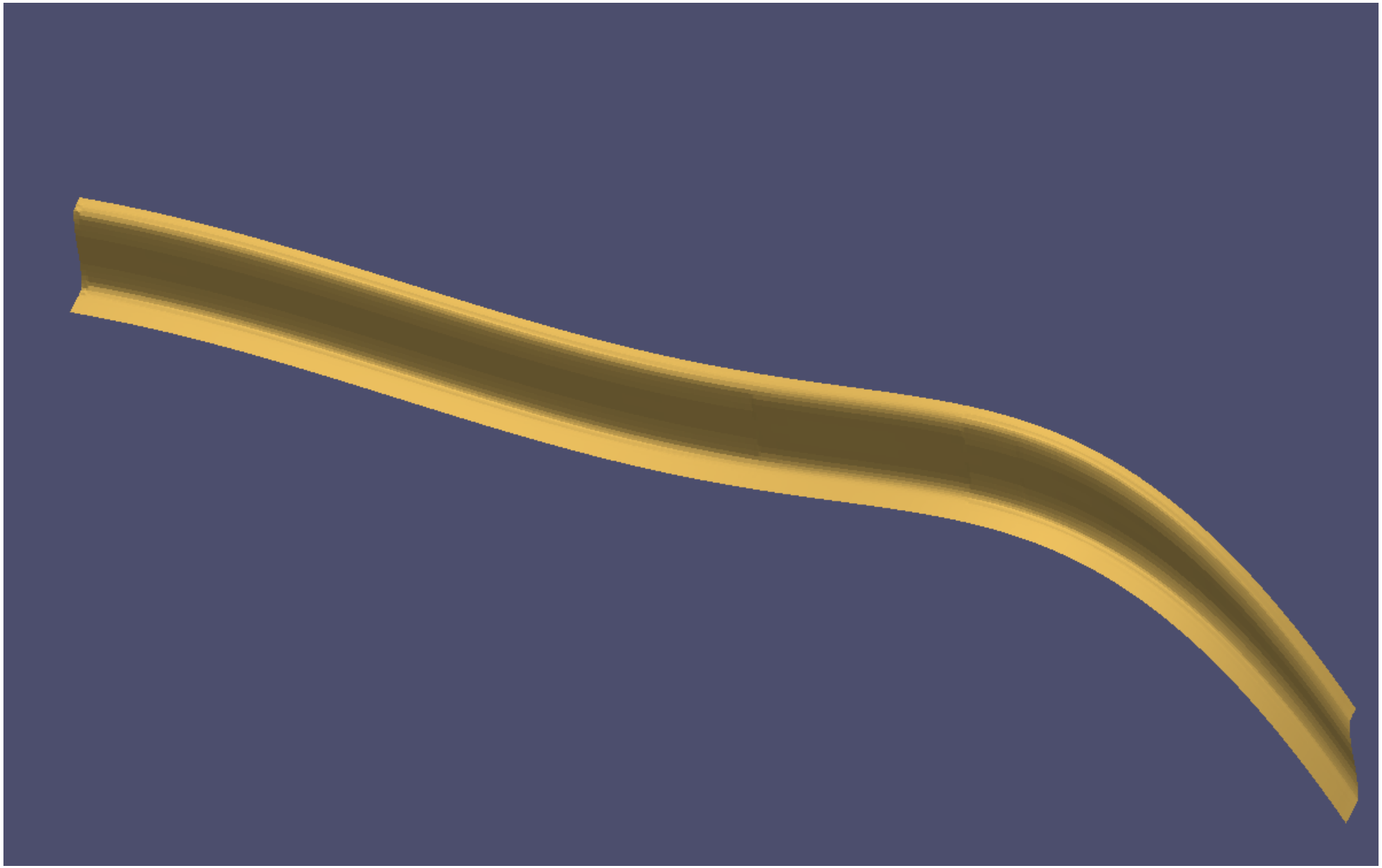
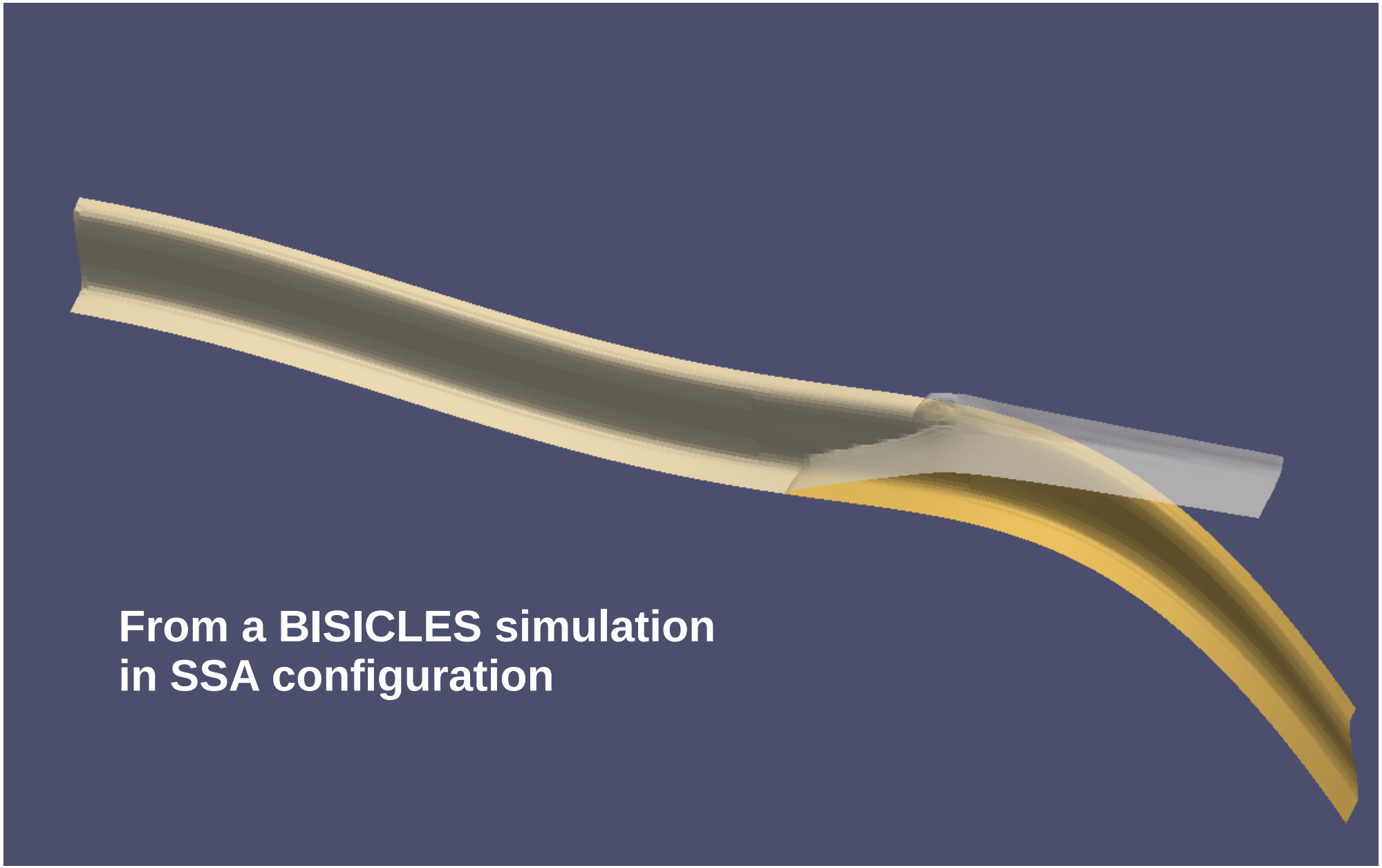
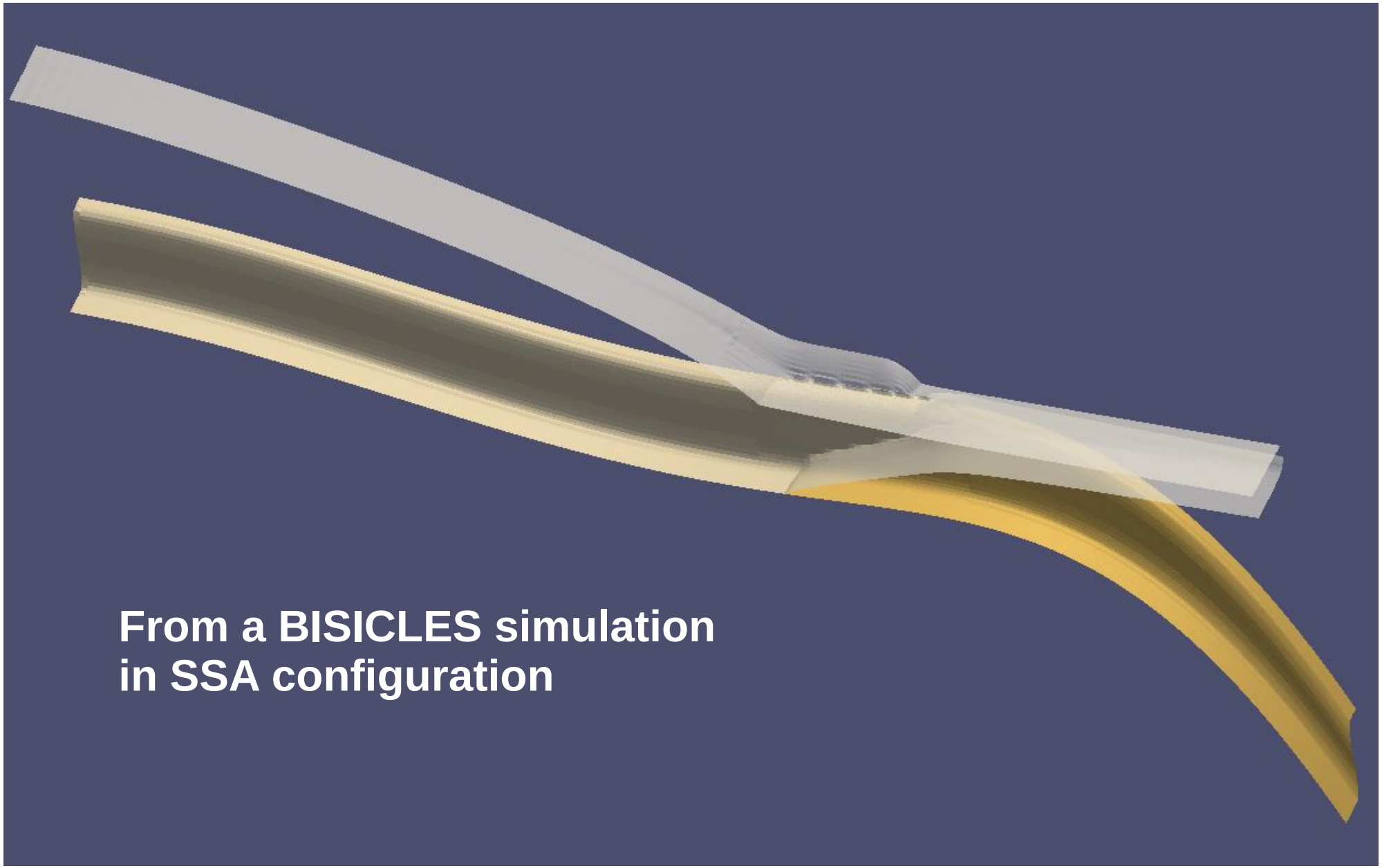


MISMIP+ steady-state ice draft



MISMIP+ steady state



MISMIP+

The Experiment:

- Begins at steady state with no melting
- 100 years of retreat w/ strong, depth-dependent melting based on Galton-Fenzi (personal comm.)

$$m = \frac{\rho_w c_w}{\rho_i L} \Gamma \Omega (T_f - T)$$

$$\Omega = 0.8 \frac{z_{\text{bot}}}{500} \tanh\left(e \frac{z_{\text{bot}} - z_{\text{base}}}{200} \right),$$

$$T = 2,$$

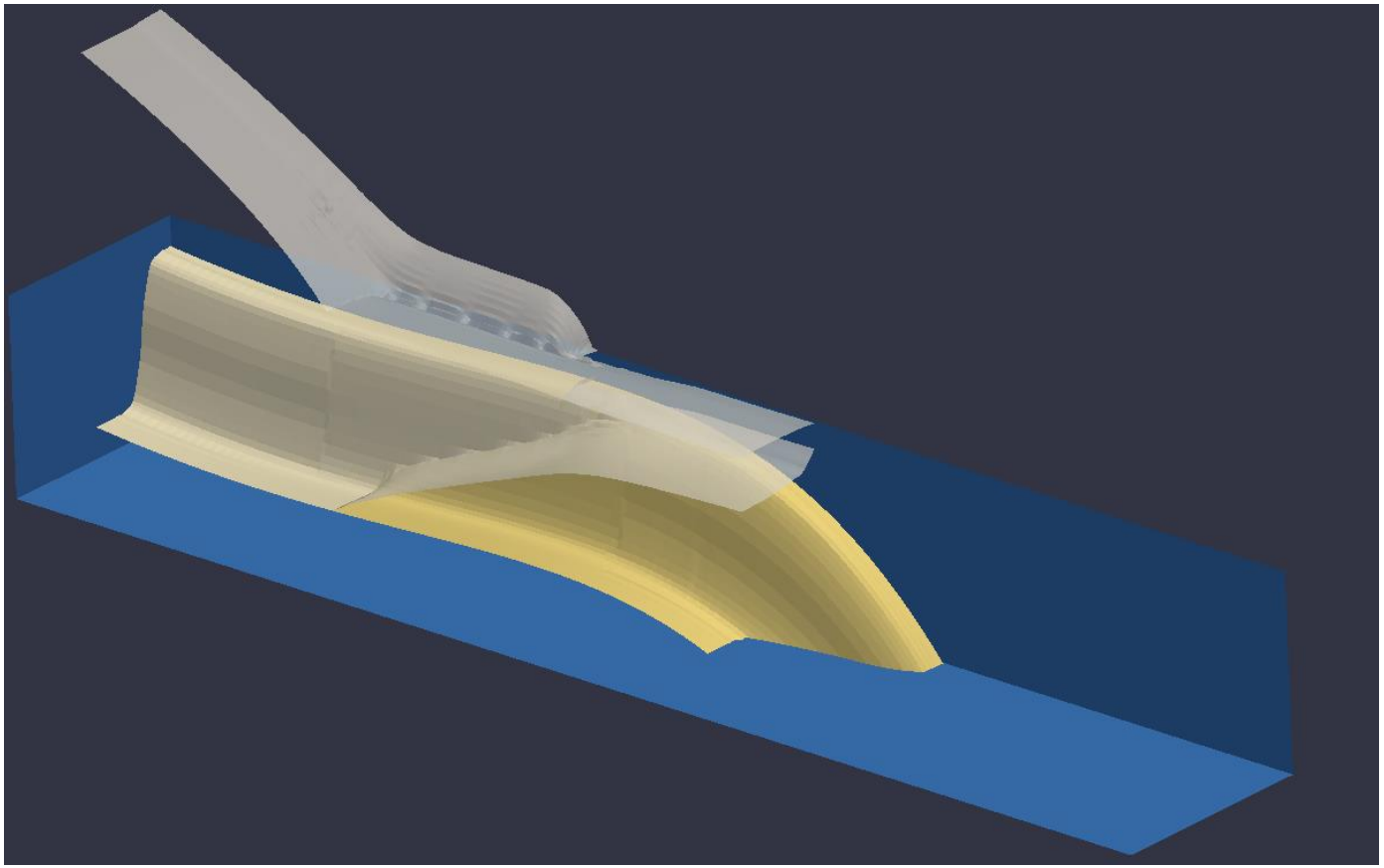
$$Tf = 7.61 \times 10^{-4} z_{\text{bot}} - 1.85.$$

- 100 years of re-advance without melting

MISMIP+ retreat

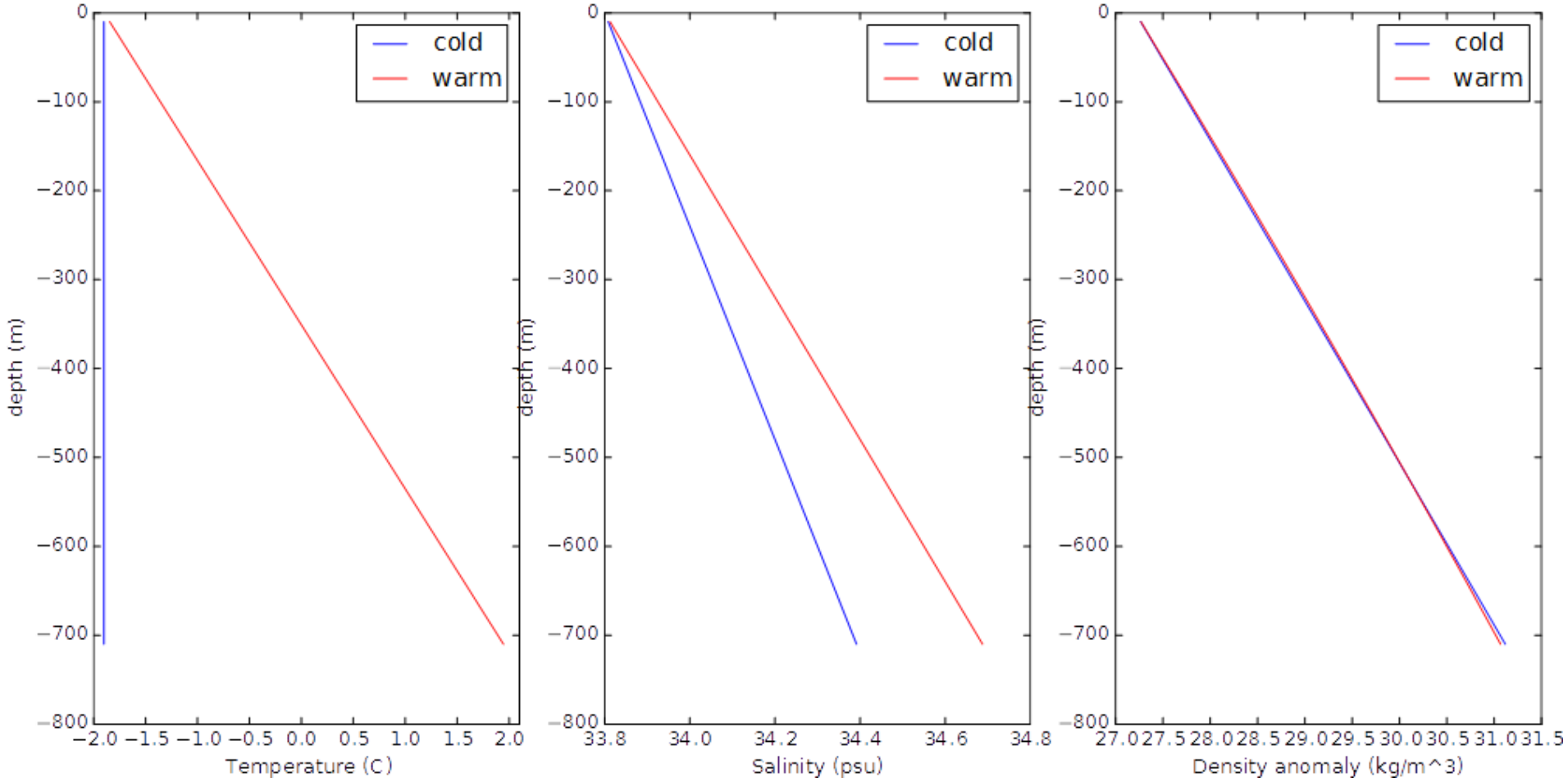
ISOMIP+

- Second Ice-Shelf Ocean Model Intercomparison Project
- Uses MISMIP+ topography (from BISICLES-SSA)
- Calving: ice under 100 m thick calves



ISOMIP+

- No sea-ice or atmospheric forcing
- COLD or WARM forcing: far-field restoring of temperature and salinity (as in Goldberg et al. 2012)



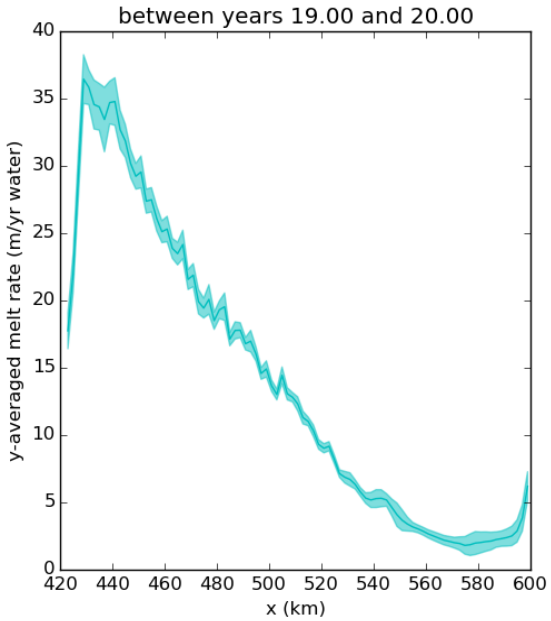
ISOMIP+ Configurations

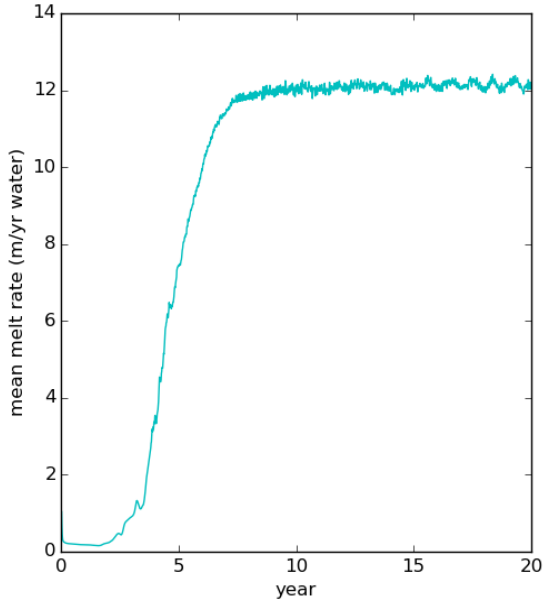
- “Typical” (TYP) configuration:
  - Ask participants to use grid resolution and parameters of a “typical” run they perform
  - Results should show spread more typical of realistic model comparisons (e.g. CMIP)
- “Standard” (STD) configuration:
  - 2 km horizontal grid;
  - 20 m vertical resolution (depending on vertical coord.)
  - Parameterizations specified (horiz., vert. diffusion; melt boundary conditions, etc.)

The Four ISOMIP+ Experiments

Two experiments with fixed ice-shelf geometry

- Validation of ice-ocean boundary conditions without further complications
- Starting point for existing models that can't do moving cavities
- Expt 1: advanced geom; cold i.c.; warm forcing



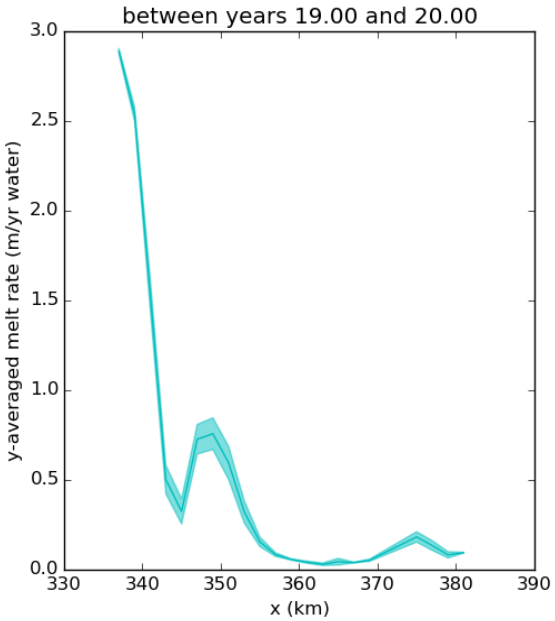


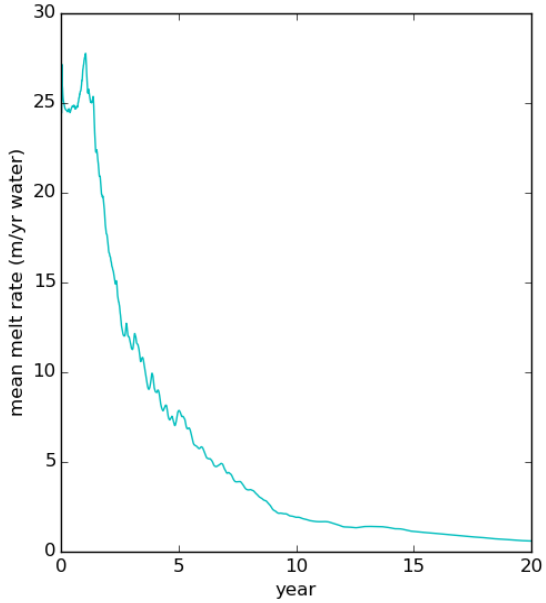
Example results from Parallel Ocean Program 2x

The Four ISOMIP+ Experiments

Two experiments with fixed ice-shelf geometry

- Validation of ice-ocean boundary conditions without further complications
- Starting point for existing models that can't do moving cavities
- Expt 2: retreated geom; warm i.c.; cold forcing



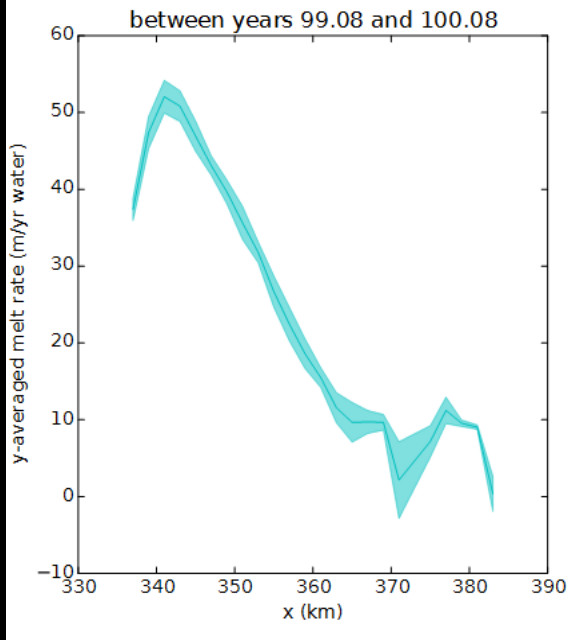


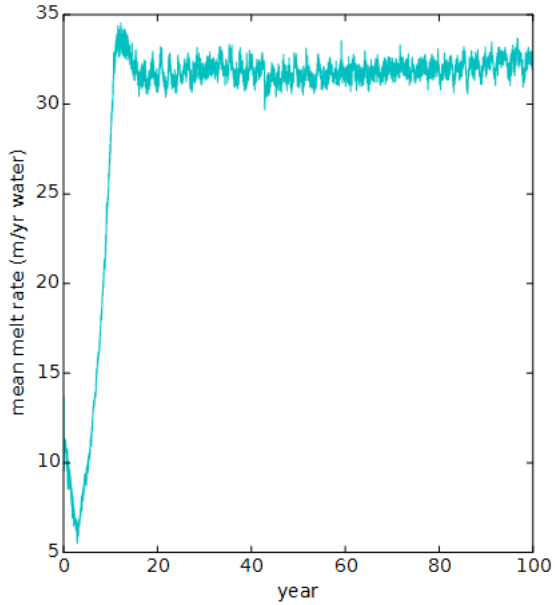
Example results from Parallel Ocean Program 2x

The Four ISOMIP+ Experiments

Two experiments with prescribed dynamic geometry

- Demonstrate dynamics boundaries before full coupling
- Expt 3: retreating geom; warm i.c. and forcing
- Expt 4: re-advancing geom; cold i.c. and forcing





Example results from Parallel Ocean Program 2x

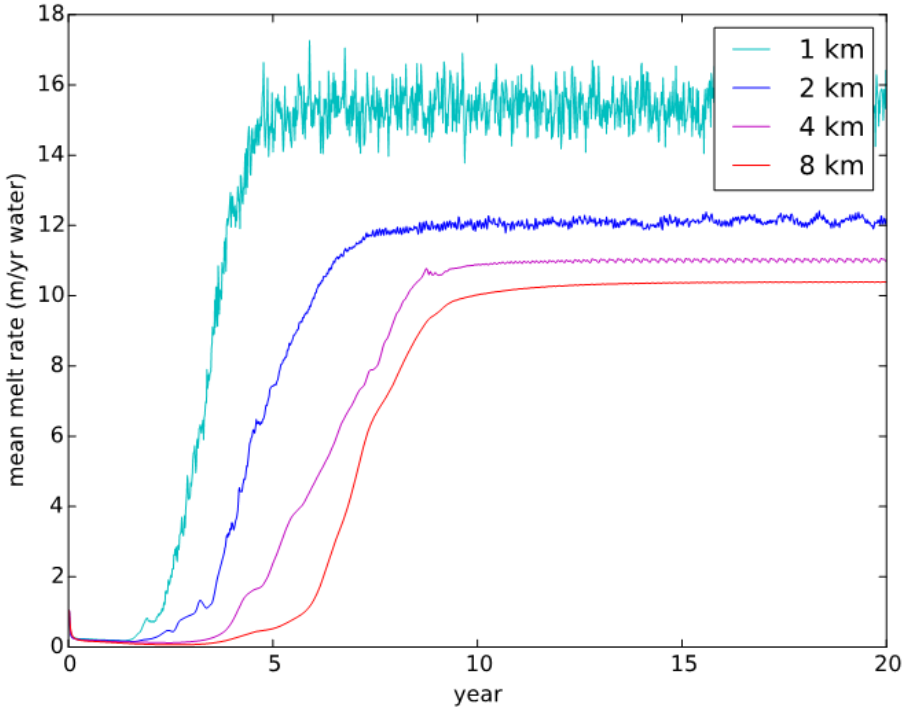
ISOMIP+: parameter studies

- Intended as reference experiments from which parameter studies can be performed
- Examples:
  - Tides
  - Atmospheric and/or Sea-ice Forcing
  - Modified bed topography
  - Modified mixing parameters/parameterizations
  - Modified melt parameterizations
  - Alternative model resolutions
  - Alternative calving law

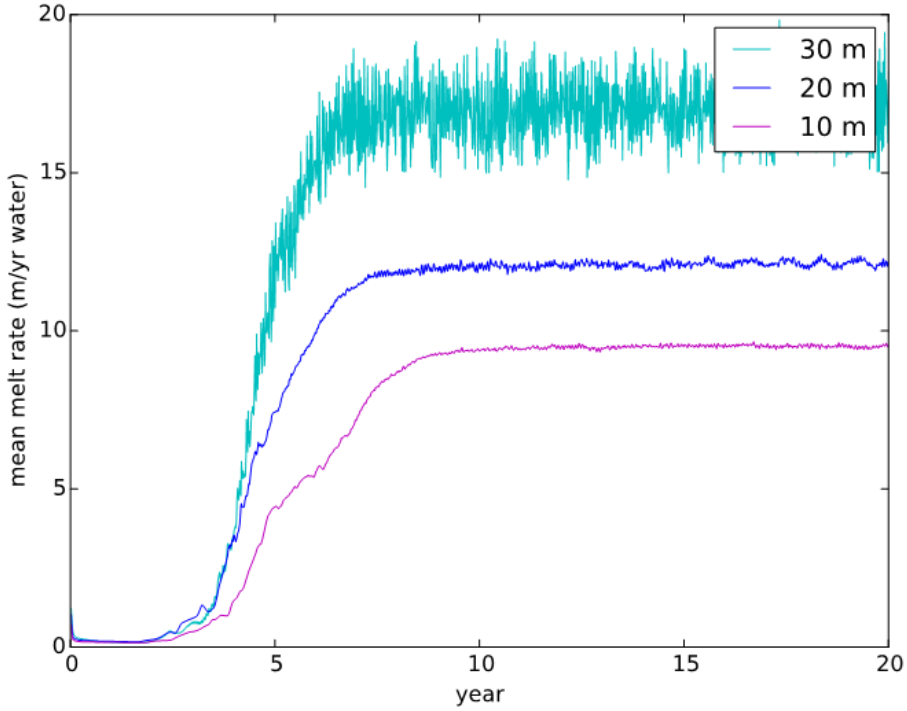
ISOMIP+: parameter studies

Results from 2 examples

Horizontal Resolution



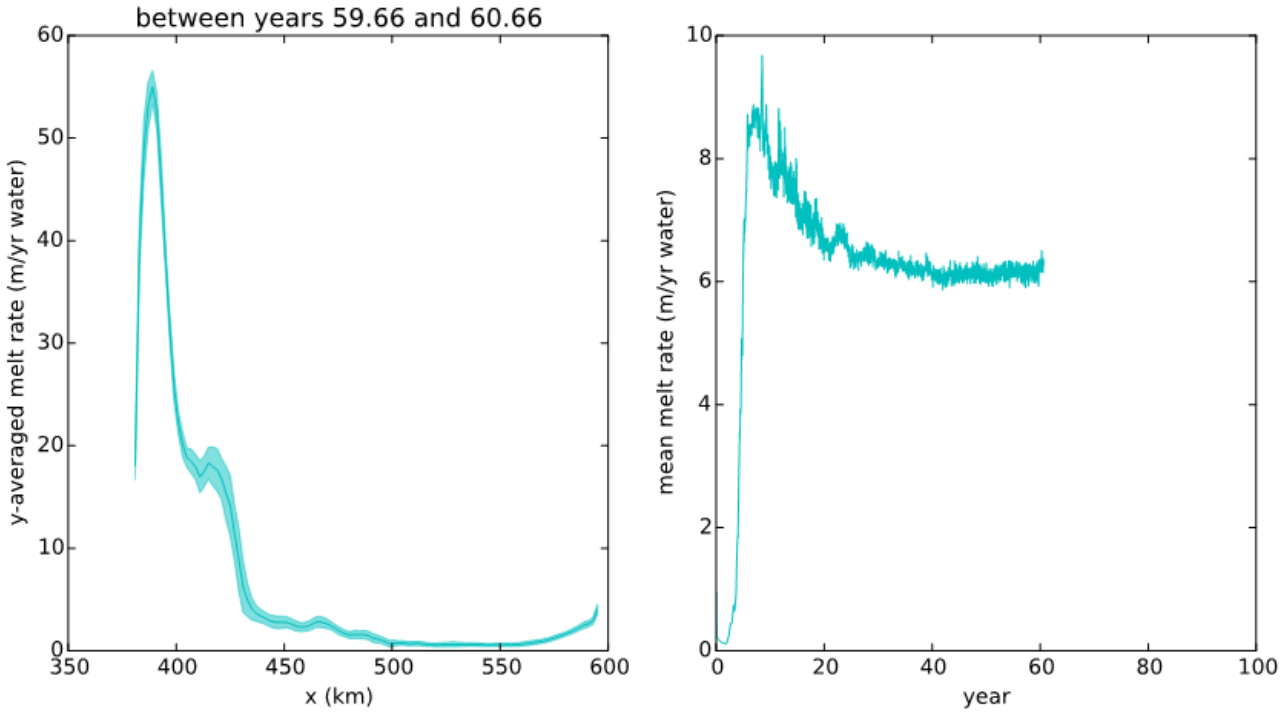
Vertical Resolution



Example results from Parallel Ocean Program 2x

MISOMIP

- Essentially MISMIP+ coupled to ISOMIP+
- 100 years of retreat driven by WARM ocean forcing
- 100 years of re-advance with COLD ocean forcing



Example results from POPSICLES (POP2x-BISICLES)

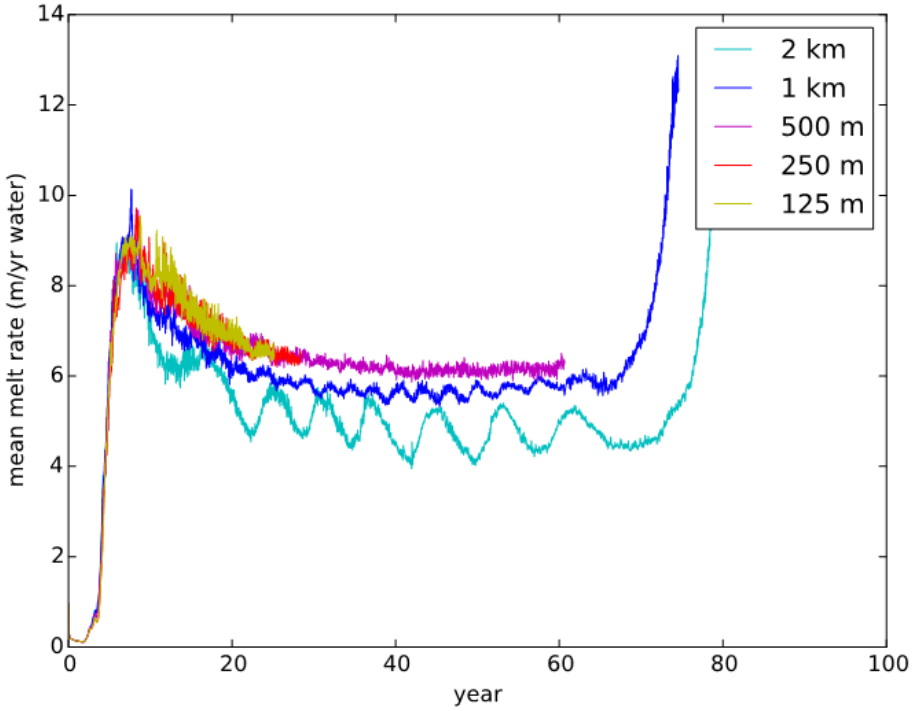
MISOMIP

Example results from POPSICLES (POP2x-BISICLES)

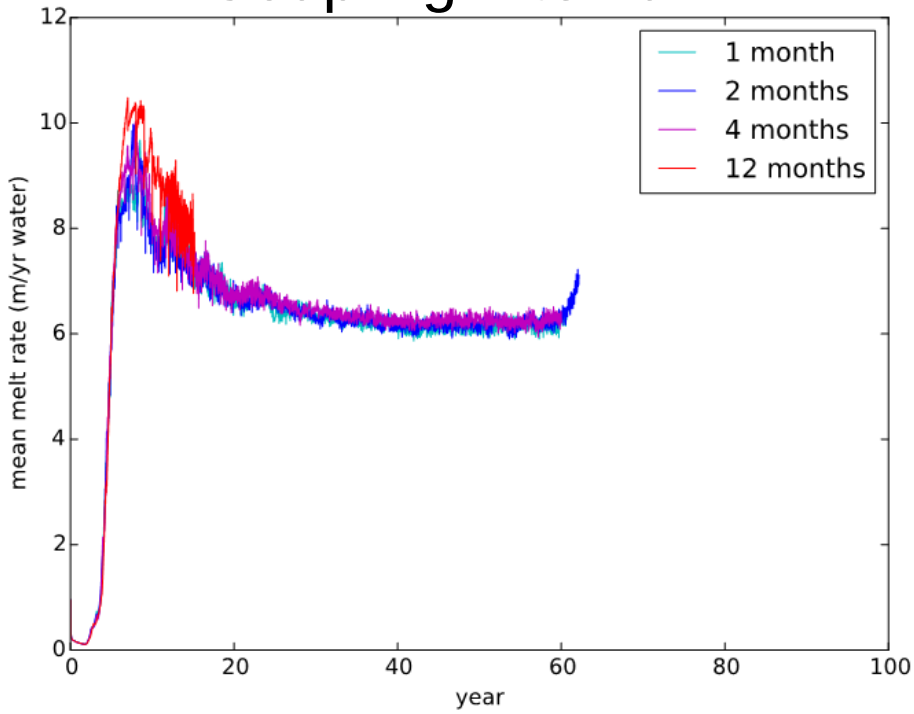
MISOMIP: parameter studies

2 examples

Ice-sheet Resolution



Coupling Interval

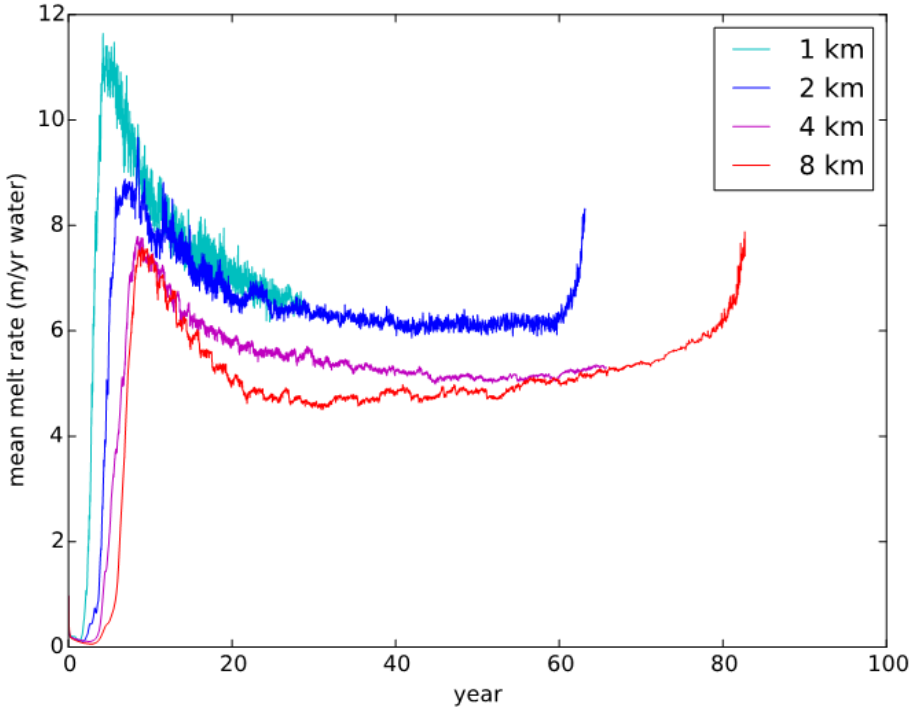


Example results from POPSICLES (POP2x-BISICLES)

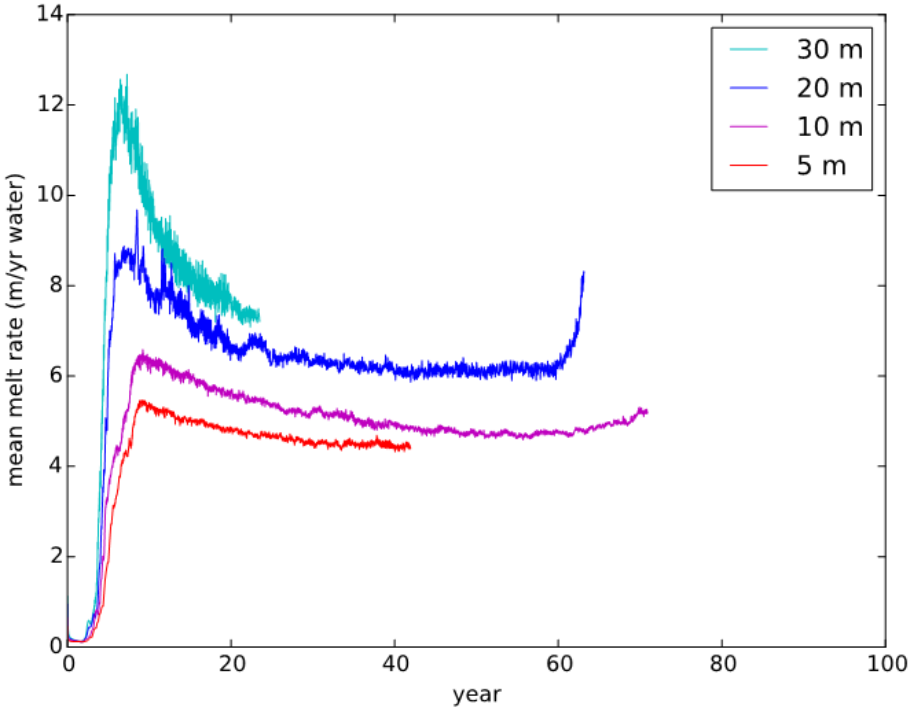
MISOMIP: parameter studies

Results from 2 examples

Ocean Horizontal Resolution



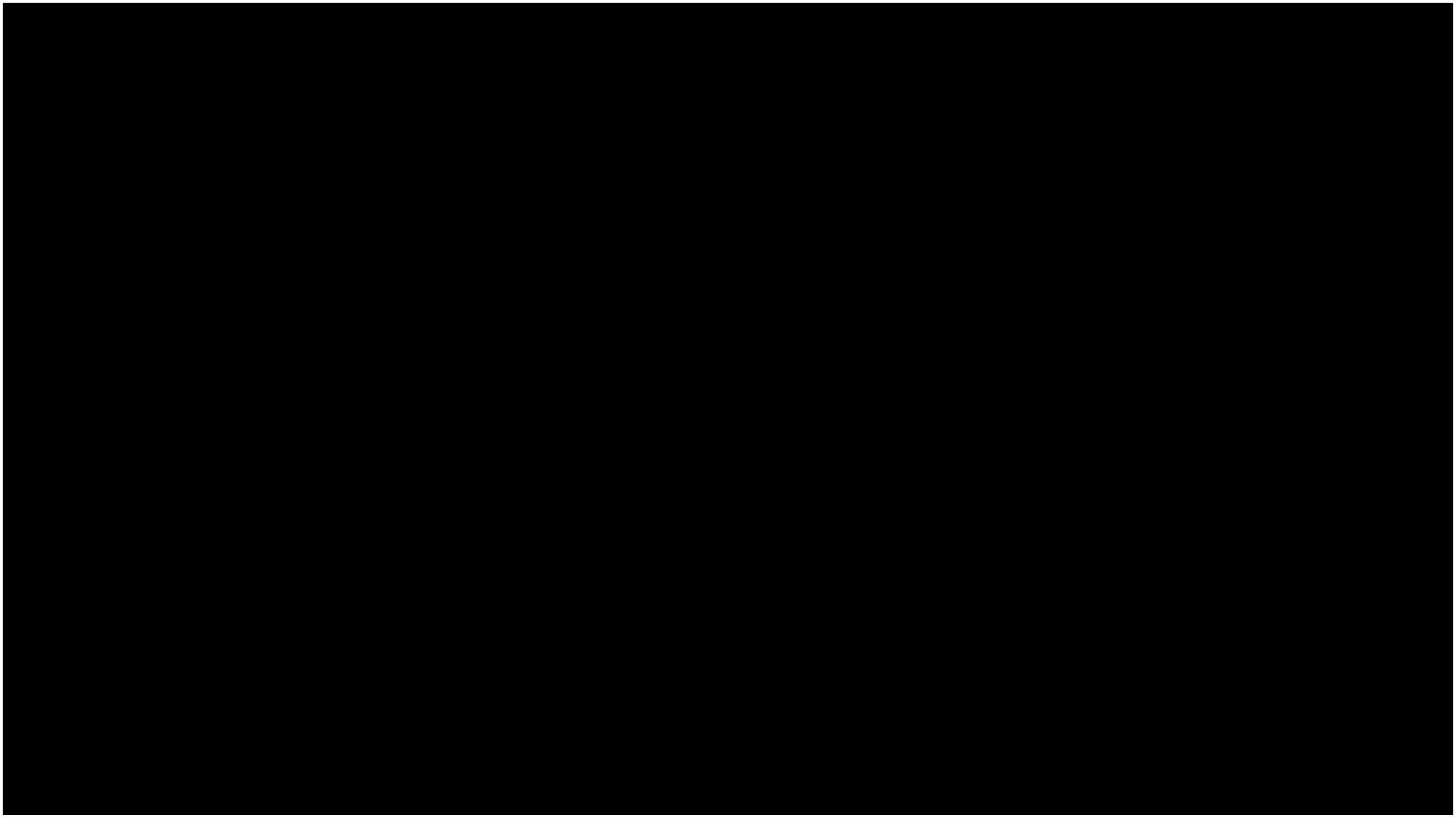
Ocean Vertical Resolution



Example results from POPSICLES (POP2x-BISICLES)

MISOMIP

- Melt channel appears at higher ocean vertical resolution (10 m)

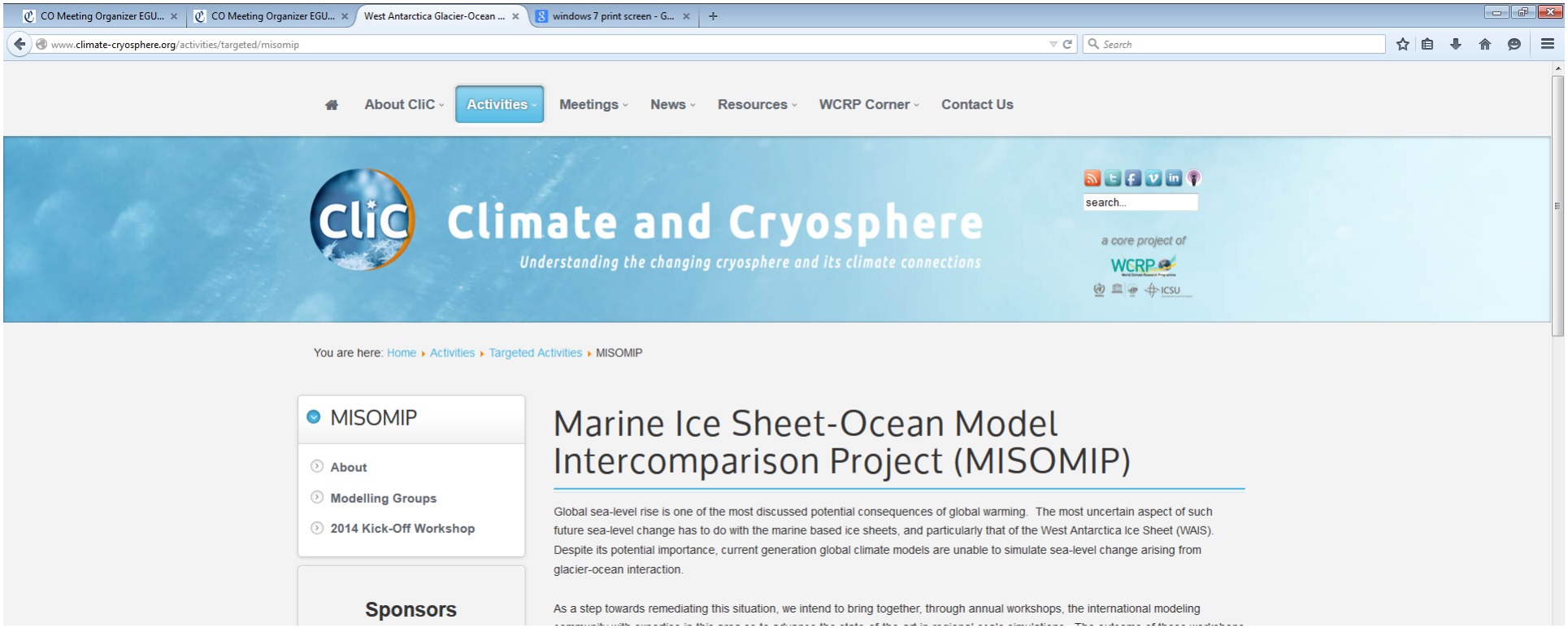


Acknowledgments

- New York University Abu Dhabi for hosting Workshops (a follow-up planned for fall 2015)
- Climate and Cryosphere (CliC) project of the World Climate Research Programme (WCRP)
- Funding from US Department of Energy (DOE) Office of Science:
  - Investigation of the Magnitudes and Probabilities of Abrupt Climate TransitionS (IMPACTS) Project
  - Predicting Ice Sheet and Climate Evolution at Extreme Scales (PISCEES)

MISOMIP Website and Email List

- http://www.climate-cryosphere.org/activities/targeted/misomip



- Example input data and results: http://portal.nersc.gov/project/iceocean/
- To join the MISOMIP Google Group, send me a request: xylar.asay-davis@pik-potsdam.de

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